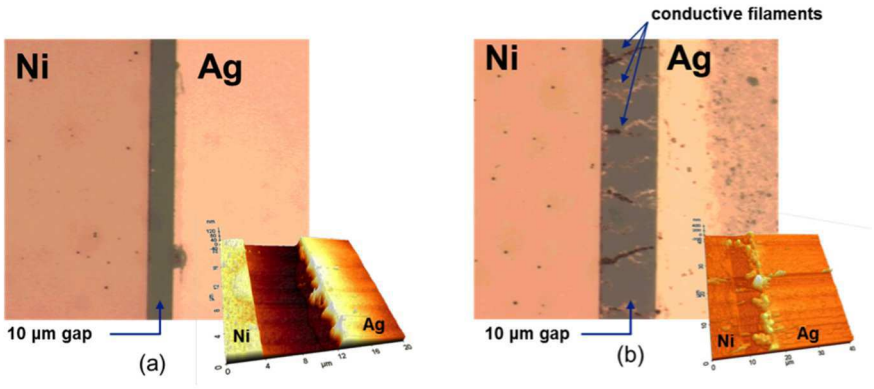


National Aeronautics and Space Administration

Communications

NanoWire Glass Switch for Radio Frequency

Invisible switch outlasts MEMS switches for RF applications

NASA's Glenn Research Center has developed nanoionics-based radio frequency (RF) switches for use in devices that rely on low power RF transmissions, such as automotive systems, RFID technology, and smart phones. These groundbreaking nanoionic switches operate at speeds of semiconductor switches and are more reliable than microelectromechanical systems (MEMS) switches, while retaining the superior RF performance and low power consumption found in MEMS all without the need for higher electrical voltages. In this new process, metals are photo-dissolved into a chalcogenide glass and packaged with electrodes and a substrate to form a switch. Since the nanoionics-based switch is electrochemical in nature, it has certain advantages over switches that are mechanically based, including non-volatility, lack of moving parts that can fail, ease and efficiency of activation, and ease of fabrication. This innovative device has the potential to replace MEMS and semiconductors in a wide range of switching systems, including rectifying antennas (rectennas) and other RF antenna arrays.

BENEFITS

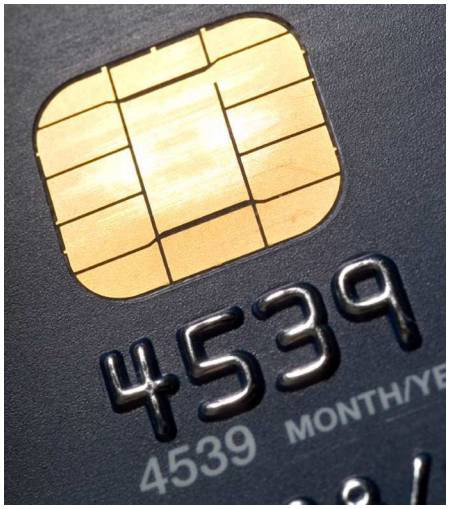
- Low power: Requires 1 volt, as opposed to 50 to 60 volts for microelectromechanical systems (MEMS)
- Lower cost: Less expensive than MEMS and uses conventional integrated-circuit fabrication techniques, with as few as five processing steps
- Simpler: Nonvolatilemeaning no power is required to maintain a particular state (e.g., ON or OFF)
- Faster: Comparable in speed to solid-state electronics
- More rugged and reliable: Maintains superior performance as compared to a mechanical connection, with no moving parts and longer mean time before failure

technology solution

THE TECHNOLOGY

The nanoionic-based switches developed by NASA's Glenn Research Center exploit the properties of some amorphous materials that can incorporate relatively large amounts of metal and behave as solid electrolytes. As with liquid electrolytes found in lead-acid batteries, for example, solid electrolytes consist of mobile ions which undergo oxidation/reduction reactions at the anode and cathode of the system. The ionic conductivity of such a material can be of the same order of magnitude as the electronic conductivity of a semiconductor but without the drawbacks of an electromechanical device.

In the nanoionic switch, ions are formed at an anode and migrate into the solid electrolyte, while electrons are injected from a cathode, thereby causing the growth of metal nanowires through the electrolyte from the cathode to the corresponding anode when a positive DC bias is applied. Once a nanowire has grown sufficiently to form an electrically conductive path between the electrodes, the switch is closed and no electric power is needed to maintain the connection, unlike in a MEMS or semiconductor-based switch. Moreover, the process of making the connection can easily be reversed by applying a negative bias, causing the wires to ungrow and the switch to open. Thus, NASA's state-of-the-art device is a reversible electrochemical switch that can have geometric features as small as nanometers. The process time for making or breaking the connection is very brief -- about a nanosecond. In addition, this nanoionic material can be deposited in such a way to form multilayer control circuits, which has the potential to minimize circuit footprints, reduce overall circuit losses, and provide unprecedented ease of integration.



Nanoionics-based switches excel in rectennas, such as those in RFID chips in credit cards

Nanoionics-based switches have a wide range of automotive applications, including GPS

APPLICATIONS

The technology has several potential applications:

- Conformal antennas for automotive collision avoidance systems and navigation; e.g., Global Positioning Systems (GPS)
- Phased arrays for communications and data storage, especially in broadcasting and radar (mobile device data streaming, military, satellite television)
- Rectennas in smart keys, safety devices, and other radio-frequency identification (RFID)-based devices
- Sensing and diagnostic systems (health care, oil & gas, utilities)

PUBLICATIONS

Patent No: 7,923,715; 8,410,469; 9,491,118

Patent Pending

More Information

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

LEW-18313-1, LEW-18313-2, LEW-18919-1, LEW-18919-2